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THE PHOSPHATE MINES OF CANADA.

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THE Ottawa river, the northeastern boundary of the Province of Ontario, and the dividing line between the latter and the Province of Quebec, has long been famous for the rafts of timber floated over its waters from the depths of the forest, and other poets besides Moore, have immortalized its beauties in verse. But with the advent of the railway which now pierces the forest solitudes, the days of rafting were numbered; and the boat song is now heard no more on "Ottawa's tide," or at such long intervals only, that, when heard, it seems an echo of the past. The lumber trade is fast leaving Ottawa City, the old headquarters of the business; and such square timber as is now cut is gradually finding other outlets than shipment to Great Britain, and other channels of transportation than the Ottawa river.

Skirting the northern shore of this great river runs a vast chain of hills, assuming at times the altitude of mountains. Their geological character marks them as remnants of the earliest land of this continent. Following the course of the St. Lawrence from the Gulf of that name to the confluence of the river with the Ottawa, the course of which latter they then pursue, the range has been styled "the Laurentians." Rolling in long undulations, with rounded, rather than rugged or pointed summits, they leave a margin of 8 or 10 miles, dipping in a gentle slope to the water's edge, rich for agricultural use, and dotted here and there with farms and settlements. Beyond this margin bold hills stretch northerly to blue mountains, rich in iron, lead, plumbago, and other minerals.

The Apatite District.—One of these minerals is apatite, or phosphate of lime, the use of which as a material for the manufacture of superphosphate as a fertilizer has become the basis of the industry bidding fair to prove ere long one of the chief elements of Canadian trade. So rapid has been the growth of this new industry that if the lumber business were to disappear from this mineral district, its void would be filled by that which has sprung up in connection with phosphate.

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These deposits of apatite, or phosphate, as it is commonly here called, are confined to a district of limited extent. Taking the city of Ottawa, the capital of the Dominion of Canada, as a starting-point, a glance at the map will show a section of country to the north, lying between the Gatineau and the Lievre, two large tributaries of the Ottawa flowing southward through the Laurentian hills, the barriers of which prevent continuous navigation, by presenting series of picturesque rapids and cascades. These tributaries are themselves rivers, some 300 miles in length; and the section they enclose, together with a belt, 4 or 5 miles wide, on the east and west, is the true phosphate country. The townships in which phosphate most abounds are Templeton, Wakefield, Bowman, Derry, Portland, and Buckingham. The only place containing sufficient population to entitle it to be called a village, is Buckingham, near the mouth of the Lievre. The Montreal and Ottawa division of the Canadian Pacific Railway passes along the river-front of these townships, and a small junction-railway connects Buckingham village with the station of that name on the main line, some 21 miles east of Ottawa. Although this place has gone through one mining experience, rich plumbago mines opened near it a few years ago having put considerable sums of money in circulation in their vicinity—until they were abandoned—Buckingham has not expanded like western mining towns, but wears a sleepy old-time aspect. The residents, apart from the families of mining foremen and managers, are more or less connected with the lumber-trade, and have been so brought up in it that no other occupation seems to have charms for them. They are a quiet, harmless folk, mostly of French Canadian stock, who take life easily, do their day's work mechanically, and when night comes on, are as happy listening to the old Norman tunes of 300 years ago, drawn out on a violin of antiquity, as if there were no to-morrow to provide for.

The rocks of the mountain range which traverse this district are composed of pyroxene, representing the "spotted gabbro" of Norway, intermixed with quartzite, orthoclase, mica, gneiss, and crystalline limestone. The phosphate itself varies much, according to locality. It is found in crystals, sometimes of large dimensions; in masses, varying from compact to coarse granular; in strata, of a lamellar texture; and in a friable form. The latter, known as "sugar-phosphate," is very abundant, and is often so disintegrated as to take the appearance of pure sand, soft enough to be dug out. The colors of the phosphate are very varied, comprising green of differ-

ent shades, blue, red, and brown of all shades, yellow, white, and cream-colored. Occasionally, beautiful crystals are found, large, and perfect at both ends, and enveloped in calc-spar; or, sometimes a drusy cavity, or "vugg," is struck, containing either one large crystal, or a number of small independent crystals shooting from the sides, or standing erect in the cavity. In one of the mines on the Lievre, crystals of gigantic size have been encountered, some weighing individually as much as one thousand pounds.

In the early days of mining in the Ottawa district, small operators were beset with countless difficulties, which materially retarded the development of this industry; but, within the last few years it has been stimulated by the investment of foreign capital, and the organization of powerful companies composed of men of practical business ability, intelligence, and means.

The first methods of mining employed here were of the rudest and most elementary kind. The only hoisting- and pumping-machinery was a tub on the end of a rope swung over the pit by a derrick worked with one horse. The pits, being as wide at the mouth as below, if not wider, were well calculated to collect all the surface-water and melting snow; and often, when the water had accumulated to a considerable extent, the pit was abandoned, and another was opened in close proximity, to have in its turn the same fate as the other. Now, however, steam-engines and improved machinery, power-drills and hoists have taken the place of the horse, the pick, and the bucket; tramways are used to facilitate transport; and a thorough business-management of the mines, generally, has placed the work on a sound and permanent basis.

Mention has been made of two rivers in this region, the Gatineau and the Lievre. The former, a favorite resort for the artist and naturalist, is rendered unnavigable by its picturesque rapids and boulder-obstructed shallows. The Lievre, on the contrary, although a series of falls and rapids extend for some distance upward from its mouth, is navigable from the village of Buckingham for some twenty miles. At the village itself, there are two very fine falls. One of these was monopolized years ago for driving saw-mills, the erection of which really created the village. The stretch of sluggish and deep water above this point is utilized to the utmost for floating down the mineral from the mines, and for conveying supplies and machinery to them. Several small steamboats ply between Buckingham village and the High Falls, some twenty miles up stream, while the ore is towed down in flatbottomed scows to a landing-place

north of the village, where the branch-line of the railway before mentioned terminates. This affords convenient transhipment into cars, from which no further change is necessary till they run on the wharf in Montreal, alongside the ocean vessel waiting for its freight. Most of the large mines are situated on or near the Lievre, along the banks of which bins have been built, here and there, to receive the ore hauled in winter and hold it until navigation opens in the spring. The greater part of the teaming is done during the winter, the snow-roads being best adapted for hauling large and heavy loads on runners, the snow being generally calculated upon from early in December to the end of March. The surface of the river during that period affords an easy road for sleighs, and these coveyances lend as much animation to the scene as the steamboats of the summer.

The High Falls, just alluded to, are formed by a mountain spur crossing the river, over which it takes a leap of eighty feet perpendicularly. No mining of any extent is, as yet, carried on above the Falls, although there is abundant show of phosphate; but several openings have been made, precursors of more extensive operations at the proper time. Mining proper has been confined, hitherto, to localities bordering on the lower stretch of navigable water.

Professor Boyd Dawkins, the British geologist, when in Canada with the British Association for the Advancement of Science, visited the phosphate district, and on his return declared, in a paper read by him at Manchester, on "Canadian Apatite," that "it would become one of the most profitable resources of this country." Professor Hoffman, the analyst of the Geological Survey staff, says that, by reason of its usually high percentage of phosphate of lime, "Canadian apatite may be regarded as a most eligible material for the manufacture of superphosphate."

In addition to the yield of pure phosphate in large masses, it occasionally happens that large quantities of it are mixed with mica, pyroxene, and other foreign substances. If shipped in that state, the value of the whole cargo would be materially deteriorated. This extraneous matter is more or less completely removed by cobbing, an easy operation, by reason of the more friable character of the phosphate as compared with the associated minerals. This is done in a hut or cobbing-house, on solid tables. On one side of the building are wagons or tram-cars, into which the refuse is thrown as broken off, while the phosphate thus cleaned is thrown into another receptacle on the other side. Boys and old men are employed at this work, which no machinery has yet been found adapted

to perform. In spite of every care used, large quantities of phosphate have thus been thrown aside, but these are now utilized by pulverizing and further treatment, much in the same way as the early gold workings of California and Australia yielded rich returns when their tailings are again worked over.

The drawback to the conversion of the crude material into superphosphate in the vicinity of the mines, to obviate shipping the raw material, is the absence of pyrites in the apatite district, in quantity sufficient to warrant the erection of works for the manufacture of sulphuric acid, by means of which the mineral is converted into a fertilizer. The nearest deposits of pyrites in any abundance are those worked in the district southeast of Montreal, known as the Eastern Townships, some 200 miles distant from the apatite region. The cost of transport thence would be more than it now costs to ship the crude phosphate to Europe. If pyrites should, at some future day, be discovered near the phosphate mines (where it has been already found in small quantities), there would be little difficulty in manufacturing fertilizers on the spot, and a very large and new industry would spring up. The water-power of the Gatineau and Ottawa rivers is unsurpassed, and would afford every facility for grinding the ore, prior to treating it chemically with the acid.

A curious feature in the phosphate trade is the fact that, although a large amount of American capital is invested in Canadian mines, almost the whole of their product is shipped to Great Britain and the European continent, a trifling quantity only finding its way to the United States. Considerable crude phosphate and a large amount of superposphate are imported into the United States from Great Britain; and there is every reason to believe that both these articles are Canadian products, reshipped. Mr. Torrance, a phosphate expert, gives, as his idea of the reason of this anomaly, that American dealers were in the habit of importing from Britain long before Canadian deposits were worked, and that no effort has since been made to direct into fresh channels the trade from Canada, which was commenced with the English market by men more familiar with that than with the American. The late Dr. Sterry Hunt, in a paper entitled "Studies of the Apatite Deposits of Canada," read before the American Institute of Mining Engineers, at Halifax, remarked that in the near future a large market will be found for this material in the United States. The growing demand for high fertilizers on this continent, and the fact that the apatite of Canada may be shipped to the valleys of the Ohio and Mississippi at much

lower rates than the phosphate-rock of South Carolina, give great importance to these Canadian mines.

The large increase in the annual output of the more important mines, is evidence that Canadian phosphate is coming more and more into demand, as the mineral becomes better known. The high grade of this phosphate has brought it into favor in Belgium, Denmark, France, and Germany, in which countries there is an increasing consumption, consequent on the widespread cultivation of the sugar-beet, for which super-phosphate is found to be an admirable fertilizer. In England there is a wide market for it. The objections which Canadian phosphate encountered at first, and the difficulties of introducing material from a new source, have been overcome. A low grade of Belgian phosphate is found to combine well with Canadian, under chemical treatment. There is a question as to the continuance of the supply of Spanish phosphate, which, with the high cost of the Norwegian article, favors an increased demand for the supply from Canada.

Besides the phosphate-bearing districts of the Province of Quebec, described above, there is also a phosphate region in the Province of Ontario, occupying that portion of the country lying back from Kingston and Belleville, which extends in a belt through the townships of Burgess, Crosby, Bedford, Storrington and Loughborough, in the county of Hastings. A large number of surface-openings exist in this belt, some of which are worked with fair returns; but no deep mining has been carried on. While the productiveness and easy accessibility of the Lievre mines have caused the neglect of the earlier-discovered deposits of the Hastings district, there are among these, some which, when properly developed, will probably be found not inferior to those on the Lievre. So far as is known at present, however, the grade of phosphate is not as high as that of the Quebec mineral; and the amount shipped from Kingston is comparatively small.

Dr. Sterry Hunt, who made Laurentian rocks his study for upwards of thirty years, regards many of the apatite veins as fissures or cavities which have been filled by the deposition of materials derived from the adjacent strata. One striking feature developed in this mining is the great irregularity of the deposits; but taking into consideration the extremely disturbed character of the Laurentian rocks, this is not to be wondered at. What may at one time have been layers, regular and uniform, subsequent disturbances and upheavals have folded over and twisted and dislocated till in one

place the matter has been compressed into the narrowest of seams, only to swell out further on, giving the appearance of huge pockets, apparently isolated, if the connecting vein be not traced or traceable.

Statistics of Production.—Some idea of the magnitude this business is assuming may be gathered from the following returns, showing the exports of phosphate from Canada since 1878, when the industry may be said to have been fairly launched:

Year.	Tons.	Value.
1878,	10,743	$208,109
1879,	8,446	122,035
1880,	13,060	190,086
1881,	11,968	218,456
1882,	17,153	308,357
1883,	19,716	427,668
1884,	21,709	424,240
1885,	28,969	496,293
1886,	20,440	343,007
1887,	23,152	433,217
1888,	18,776	298,609
1889,	29,987	394,768
1890,	28,457	499,369
1891,	15,153	119,532
	267,729	$4,483,746

Of the above, 17,744 tons were shipped from the Province of Ontario, and the figures of exports from Quebec include a certain amount produced in Ontario, but shipped to Montreal for export, and at that port credited to the Province of Quebec.

Owing to a depressed market the shipments in 1892 fell off considerably. The complete returns are not yet announced.

That there is room in England for all the phosphate Canada is likely to produce, is shown from the following table taken (except the percentages) from British returns:

Imports of Phosphate into Great Britain.

Year.	Total Imports, Tons.	From Canada, Tons.	Percentage from Canada.
1882,	223,394	9,169	4.1
1883,	276,578	18,514	6.7
1884,	245,532	17,603	7.1
1885,	272,200	24,062	8.1
1886,	249,884	20,237	8.1
1887,	317,424	21,497	6.7
1888,	288,832	13,913	4.8
1889,	341,547	25,898	7.5
1890,	384,721	23,619	6.1

The official returns for 1891 have not been obtained.

Mr. Obalski, government mining engineer of the Province of Quebec, in a paper read by him in October last, says:

"Recent important discoveries in different places in Europe and the United States have caused a variation in the price; but nevertheless, we can say that the Canadian phosphate, considering its high average (80 per cent.) will have a regular market; and I consider that if the production is not greater it depends more on the irregularity of the deposits than on any other cause. Up to date the production has been some 250,000 tons. There exist large deposits not yet worked, on account of the absence of easy means of transportation.

"The depression in the European market is evidenced by the very limited extent of the phosphate-mining operations in this district. The High Rock mine,* with a reduced force of about sixty men, has raised about 3000 tons of all grades, to date, about 2000 tons of which has been exported. The Squaw Hill, and Etna mines of the British American Phosphate Company are the only other mines now worked to any extent. Recent operations reveal some fine shows of the mineral; and the management are reported to be encouraged by the prospects."

Whether phosphate in its crude state, pulverized, is available as plant food has not been as yet fully ascertained, although the results of experiments go to show that when mixed with strong fermenting stable-manure, or with swamp-muck, its effects are manifested, in the former case, rapidly, in the latter more slowly. The same results have been obtained with Charleston rock. There are only at present three manufacturers of fertilizers in Canada; in New Brunswick, Quebec, and Ontario, respectively. Almost the entire product of the crude material, however, is sent out of the country.

Cost of Mining and Transportation.—Information gathered from various sources as to the cost of a ton of phosphate delivered in Montreal compared with that stated in the latest Quebec Government Report on Mining and Minerals,† gives the following figures:

Extraction (profitable average), $3 to $6.

Transport to wharf over a distance of 1 to 5 miles, by cart, 25 cents to $1.25.

Transport to wharf over a distance of 1 to 2 miles, by tramway, 20 cents.

* The property belonging to the High Rock mines worked by the Phosphate of Lime Company, of London, England, under the management of Mr. Pickford, covers 1200 acres, and these mines have been probably the most successful in their operation. At one time the number of hands employed was upwards of 200, and every means were used to promote their welfare, even to a reading-room well supplied with books and periodicals. The number of the hands at any of the mines varies with the demand for the material.

† *Mines and Minerals of the Province of Quebec*, by J. Obalski, Government Mining Engineer, Quebec, 1891.

Transport by river in barges over a distance varying from 10 to 25 miles, 30 to 60 cents.

Cost of transhipment at Buckingham, 10 cents.

Transport by railway from Buckingham to Montreal, $1.25 to $1.50.

Cost of transhipment at Montreal, 25 cents.

Commission, insurance, etc., 50 cents.

Ocean-freights range from five to twelve shillings sterling, according to the port of destination, Hamburg being the most distant to which phosphate has been shipped hitherto.

Wages.—The rate of wages is from $15 to $25 per month, with board; and, by the day, 90 cents to $1.25, without board for ordinary laborers, and $1.50 to $2.50 for foreman and machinists. A team and driver average $3 per day.

Mills.—There are three mills for grinding phosphate run by the water-power of the Lievre river, near Buckingham station, viz.:

One belonging to the Canadian Phosphate Company with a capacity for turning out six to seven tons a day.

One at Seabury, on the west side of the Lievre, run with a turbine wheel, and equipped with a rotary driver, capable of treating twenty-five tons a day.

One belonging to Lomer, Rohr, and Co., with a capacity of from forty to fifty tons a day.

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